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## Poster Session 1 – Rodent Management

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### 25 Bio-economic model of muskrat control

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Bio-economic models provide a tool to choose between alternative strategies of management for pest- or predator populations. Such model was constructed for the case of Muskrat control in the Netherlands, in order to investigate under what assumptions qualified eradication would be economically more optimal than year-round control or no-control. The Muskrat is an invasive alien species endangering public safety by burrowing in levees and dams. The model consisted of three components, 1) a discrete logistic population model, and formulas capturing 2) the trapping process and 3) the costs of control, prevention and damage. The population and trapping components were calibrated with success against existing time series of catch and effort. The model results clearly point at qualified eradication as being optimal from an economic perspective, under realistic assumptions for Muskrat control in the Netherlands. It identified that trappers may be limited by time required for inspection and control of traps, which explains why-in practice-control tends to become less costly when a situation of greater control is attained. Furthermore the model points at the relative importance of the required investments in preventive measures versus the costs of damage inflicted by Muskrat. The first costs are related to the prevention of the most important damage and the reduction of risks for public safety by fortification of flood walls and/or banks of water bodies. For the case of the Netherlands, it is the sheer magnitude of the required investment in preventive measures, under a policy of no-control, that would make such strategy more expensive than qualified eradication, independent of the damage costs that can reasonably be expected.

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## Poster Session 1 – Rodent Management

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### 26 Prevalence of rodenticide resistance in Singapore's rat population

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Rodenticide resistance poses a major challenge for vector control. Single Nucleotide Polymorphisms (SNPs) in the gene VKORC1 have been associated with anticoagulant rodenticide resistance in rats. Although extensive studies have been carried out mainly in Europe, few studies have been carried out in southeast Asia. The aim of this study was to characterise the frequency and distribution of VKORC1 SNPs in the rat population in Singapore. DNA was extracted from forty-two (42) *Rattus norvegicus* and *Rattus rattus* spp. tail samples collected from various parts of Singapore. Exon 3 of VKORC1 was amplified by PCR prior to Sanger sequencing. Electropherograms of the results were analysed for SNPs and codons of interest were located in exon 3, mainly 139, 128 and 120. There were no polymorphisms in VKORC1 exon 3 of the rat samples screened. However, four samples were found to have either heterozygous or homozygous missense mutation for codon 143 (Ala>Val). We did not detect any evidence of VKORC1 mutations associated with anticoagulant rodenticide resistance in the samples we have screened. More extensive sampling will be carried out to determine if anticoagulant rodenticide resistance is present among rodent populations in Singapore.

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## Poster Session 1 – Rodent Management

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### **27 Which factors drive the genetic differences of Norway rats (*Rattus norvegicus*) on farms?**

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Norway rats (*Rattus norvegicus*) commonly populates farms where they are controlled because they can be reservoirs and vectors for several human and animal pathogens. Understanding the biological and ecological processes that are involved in the distribution of rats is necessary for effective management measures. This is of particular importance because Norway rats have developed genetically based resistance to anticoagulant rodenticides that are commonly used for pest control. Distribution of resistant Norway rats seems to be determined by intrinsic factors such as sociality and dispersal as well as by application of anticoagulant rodenticides. We describe the distribution of Norway rats on farms located within the resistance area of Germany. Therefore, we analysed genetic differences at population level defined by the frequency of resistance (mediated by Y139C alleles) and the kinship of more than 200 individuals. Besides rodenticide application practice, also farm and landscape structures were assessed as potential extrinsic factors. We will present preliminary results and highlight the importance of local factors determining resistant rat distribution.

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## Poster Session 1 – Rodent Management

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### **28 Phenology of Norway rats, *Rattus norvegicus*, in the sewer system of Barcelona (Spain)**

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Norway rats are a synanthropic species and they represent a problematic pest species in cities all around the world. Effective surveillance and control strategies demand information on the biology, ecology and behaviour of this species. Norway rats can reproduce all year round, declining activity in winter, especially where temperature drops under 0 °C. The Agència de Salut Pública de Barcelona, in the framework of the rodent surveillance and control program carried out in the city, started, in 2016, a project that included a study on the biology and ecology of the brown rat population in Barcelona. From December 2016 to November 2017, a total of 580 Norway rats were captured with kill traps placed in the accessible sewer system of the city. All dead rats were dissected, and we determined their sex, age and reproductive activity. The results show that in winter, both male and female rats have the highest rates of sexual inactivity (30%-60% for males and 40%-55% for females), while most of them are active for the rest of the year. Although temperature inside the sewer system of Barcelona rarely descends under 10 °C, reproductive activity apparently stops during the months of December and January. The highest frequencies of pregnant females and females with scars in their uterus were found from March to June, suggesting a reproductive peak in spring, and contrary to what other authors have reported, no reproductive peak was found in autumn. The results of the present study will be very useful to the design of surveillance and control strategies for this species in the city.

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## Poster Session 1 – Rodent Management

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### **29 Predation by *Rattus rattus* on the *Hantavirus* reservoirs rodent, *Oligoryzomys longicaudatus* in Laguna del Laja National Park, Chile**

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Rats are known to introduce disease and to displace native small mammals through competition and predation. In spite of the dramatic impact on other animals (e.g. seabird, small lizard, snakes eggs and insects), the effects of rat predation on small mammals may be overlooked because it is poorly known, difficult to document, and has not been the focus of research. In Chile, the black rat *Rattus rattus*, is widely distributed with naturalized populations that had invaded natural areas in the Mediterranean zone and coastal forest but, limited by desert, high altitude and high latitude. Here, we recorded the species richness and abundances of rodents in a deciduous forest (Laguna del Laja National Park, South of Chile) during winter and spring of 2013 and, correlated these data, with the potential predation by the black rat. Our outcomes account the winter as more diverse (five species) and abundant (52 individuals) season for the presence of rodents, with the species *Abrothrix olivaceus*, *Abrothrix longicaudatus*, *Oligoryzomys longicaudatus* and the exotic *Rattus rattus*, being *Oligoryzomys longicaudatus* and *Rattus rattus*, the most and less plenty respectively. In spring, only nine individuals of *Abrothrix olivaceus* and *Oligoryzomys longicaudatus* were recorded. The analysis of teeth and hair under electron microscope images of the stomach contents for the five *Rattus rattus* captured in winter, are showing a selection for the abundant long-tailed pygmy rice rat *Oligoryzomys longicaudatus*, a native rodent considered as the major reservoir of *Hantavirus* in Chile and Patagonian Argentina. In addition, our results are indicating a seasonal distribution of the black rat in the area (not present in spring), and open the question on its predation conduct on this *Hantavirus* reservoir in other places of its distribution, as well as on the other small mammals and small animals in Chile.

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## Poster Session 1 – Rodent Management

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### 30 Common vole dynamic and its crop preferences in the agroecosystems during a ten-year study

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In the Czech Republic data on the common vole (*Microtus arvalis*) abundances (burrow index - BI) were collected in various agricultural crops in spring and autumn. A ten-year data set may cover enough spatial and temporal variation in the natural population fluctuations to allow for the test of the effect of various crops and climate on the common vole, which is the most abundant central European herbivorous rodent. The highest BI was in permanent crops (i.e. alfalfa, clover, grasslands, meadows and orchards). The winter crops were also suitable habitats. Higher densities were found in winter rape compared to winter wheat which provides higher cover and availability of biomass in autumn and winter. We assume that the vole population migrated to spring crops (e.g. spring barley, sugar beet) as soon as some food biomass was available, their populations went fast up to higher densities compared to winter crops. Three minima and maxima in common vole burrow densities were found within ten years. Low but non-zero densities were found in foraging crops. We suppose that during low population densities these habitats being a refugium for common vole populations. In contrast to this, the population of common vole in winter cereals reached the population minimum (mostly zero BI). The climate (expressed by NAO index) has affected common vole populations in all types of crops equally. Positive values of spring and winter NAO (which indicates mild and wet weather) were negatively correlated with BI. We assume that mild weather during winter and early spring may cause flooding of the burrow system and rain and subsequent freezing severely limits their access to food. On the other hand, BI was positively correlated with negative value of winter NAO, indicating a positive effect of more snow days.

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## Poster Session 1 – Rodent Management

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### **31 Effects of anticoagulant exposure on non-target species using four species of reptiles as surrogates**

**Katherine Horak, Richard Mauldin, Rachael Moulton, Gary Witmer**

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The introduction of rodents and other non-native mammals to island ecosystems poses a serious risk to native species. These native species have often evolved without pressure from predators and therefore, invasive rats frequently cause a precipitous decline in population size leading to these species being listed as threatened and endangered or extinct. Moreover, rodents cause serious damage to agricultural crops and pose a threat to human health through the spread of disease. Because of these negative impacts there has been a concerted effort to control rodent populations and eradicate introduced rodents from islands. Anticoagulant rodenticides are the mainstay for these rodent control operations. However, the risks they pose to non-target reptiles have not been well characterized. As an initial step to determine potential non-target risks, four reptile species, ameivas (*Ameiva exsul*), boas (*Boa constrictor*), wood turtles (*Glyptemys insculpta*), and iguanas (*Iguana iguana*), were orally dosed with two levels of the anticoagulants diphacinone and brodifacoum. Animals were dosed twice and monitored for 14 days for signs of anticoagulant intoxication. Residue levels of both diphacinone and brodifacoum were determined. None of the turtles, boas, or ameivas died due to anticoagulant exposure. However, anticoagulant exposure is suspected as the cause of death in one iguana that was dosed with brodifacoum. Liver residue levels were higher than whole body remainder residue levels for all species. Unlike the other species, turtles had higher diphacinone residue levels than brodifacoum. This study provides data for future assessments of the risks to non-target reptiles associated with anticoagulant use.

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## Poster Session 1 – Rodent Management

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### **32 Developing ecologically-based rodent management for smallholder farmers in Zambia**

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Rodent pests have significant negative effects on smallholder farming communities in Zambia. Currently, farmers often do nothing to control rodent pests and sometimes use rodenticides when problems become severe. As the use of rodenticides is both expensive for smallholders and a danger to wildlife and farmers, there is an urgent need to develop humane and ecologically based rodent management strategies. The current study seeks to understand the effect of habitat fragmentation on the diversity of rodents and their small mammal predators; understand rodent population dynamics in Zambian maize fields; understand how landscape issues may affect anti-predator and foraging behaviours of rodents; and to compare the effects of using fertility control vs. mortality control on rodent population dynamics and maize crop damage. Sherman live traps will be used to capture rodents while rodent predators will be surveyed using camera traps, stratified across a range of habitats and seasons. The population dynamics of rodents in smallholder maize farms will be assessed using capture-mark-recapture (CMR) techniques. Foraging behavior of rodents in relation to different habitats and predator abundance will be assessed using giving-up densities to assess the landscape of fear. To compare the effect of fertility and mortality control on rodent populations in maize farms, three trapping grid treatments (replicated twice across two seasons) will be established in different maize fields. After a baseline population assessment, each grid will be exposed to a different treatment (contraceptive bait, rodenticide bait and untreated bait). The population of rodents will be monitored monthly during the maize growing season using CMR, and rodent damage assessments will be taken using standard methods. Outcomes of this study will help enable the development of ecologically sustainable and humane methods for controlling rodent pest populations in Zambia.



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## Poster Session 1 – Rodent Management

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### 33 Modelling and simulation of the toxicokinetics of fungicides in common voles (*Microtus arvalis*)

**Christian Imholt<sup>1</sup>, Tariq Abdulla<sup>2</sup>, Alexander Stevens<sup>3</sup>, Peter Edwards<sup>3</sup>, David Woods<sup>4</sup>, Elaine Rodgers<sup>4</sup>, Leon Aarons<sup>2</sup>, Jens Jacob<sup>1</sup>**

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Environmental risks from plant protection products (PPPs) need to be assessed to ensure safe use. In the EU risk assessments are governed by regulations and guidelines. Within these the common vole represents a focal species for small herbivore assessment due to its wide geographical distribution, preferred agricultural habitat and life history traits. The risk assessments are dose based and carried out using conservative theoretical estimates of external exposure, which are then compared to dose related toxicity endpoints established in toxicity studies with laboratory species. The aim of this study was to determine the actual internal dosimetry of PPP active ingredients (AIs) in a population of common voles to provide the basis for informed higher tier risk assessment. As a proof of concept, the toxicokinetics of two fungicidal AI (fludioxonil and cyprodinil) were investigated in laboratory, enclosure and field applications. The results were used to develop and verify 'population toxicokinetic models' (popTK) that could predict the range of internal exposure experienced by a vole population in the field. In the laboratory, the AIs were coadministered to wild caught voles via oral gavage and intravenous bolus at doses ranging from 1 to 200 mg/kg. Feeding experiments on treated grass were also performed in cage experiments. AI blood concentrations to determine toxicokinetic parameters were obtained by repeated microsampling (10 µl) followed by LC-MS/MS analysis. From the laboratory data, popTK models were developed and then used to simulate the range of blood concentrations in a semi-natural enclosure setting as well as in a field experiment. In both cases stochastic simulations successfully described the range of measured concentrations observed in semi-natural and natural populations. While this study directly used a particular focal species, the approach could also be adopted for alternative species and improve the risk assessment through greater realism and under natural conditions.

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## **Poster Session 1 – Rodent Management**

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### **34 Diversity and abundance of rodent pests and their impact on rural inhabitants of Khyber Pakhtunkhwa, Pakistan**

**Surrya Khanam**

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We have very limited knowledge on the status and biology of rodent species present in Pakistan. The present project is designed to explore the species composition, abundance and biology of rodents present in the villages of province Khyber Pakhtunkhwa, Pakistan and to assess the impact of rodent pests on farmer communities. The project aims to generate awareness among people towards rodent pest species, their health hazards and economical impact on their lives. Training rural communities towards rodent management practices is the main focus of the present study along with the collecting of baseline ecological data on rodent species present in the area. This will help in up scaling skills of farmers in rodent control tools and technologies. The project will generate useful information to develop an ecological based management plan for the control of major pest species occurring in the area and will equip farmers with the necessary training and expertise to manage both indoor and outdoor pest species.

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## Poster Session 1 – Rodent Management

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### **35 Low rates of resistance to anticoagulant rodenticides in the population of Norway rats, *Rattus norvegicus*, in Barcelona (Spain)**

**Josué Martínez de la Puente<sup>1</sup>, Sandra Franco<sup>2</sup>, Jordi Figuerola<sup>1</sup>, Jordi Pascual<sup>2</sup>, Víctor Peracho<sup>2</sup>, Tomás Montalvo<sup>2</sup>**

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Rodent pest management nowadays depends on the anticoagulant rodenticides because of their outstanding efficiency and excellent safety profile. Anticoagulant resistance is known as one of the major factors interfering with rodent control. Within this context the Agència de Salut Pública de Barcelona, in the framework of the rodent surveillance and control program carried out in the city, started, in 2016, a project that included a study to determine the presence of anticoagulant resistance mutations in Norway rats in Barcelona, northern Spain. From December 2016 to November 2017, we captured with death traps 236 rats in different sections of sewer system. A piece of tail was taken from each rat for further analysis. DNA was screened for the presence of mutations in the VKORC1 gene responsible for anticoagulant resistance. None of the samples presented mutations associated to anticoagulant resistance, and consequently the proportion of anticoagulant resistant individuals should be very low (0%, 95% confidence interval 0-1.6%). Results from this study indicates that anticoagulant resistance is not currently a problem for the control of rats in the city of Barcelona. Nevertheless, monitoring for resistance is important if we are to understand the scope of its spread and to manage resistant rodent populations.

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## Poster Session 1 – Rodent Management

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### **36 Spatial and temporal changes of diet of multimammate rat (*Mastomys natalensis*, Smith 1832) in relation to the breeding patterns in semi-arid areas in Tanzania**

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The diet and breeding patterns of *Mastomys natalensis* in semi-arid areas of Isimani division, Iringa region, Tanzania were investigated in maize fields and fallow land. The aim was to investigate the influence of diet on breeding patterns of *Mastomys natalensis*. Removal trapping was used to capture rodents and analyse diet categories while capture-mark-release trapping was used to investigate breeding patterns of females *Mastomys natalensis*. *Mastomys natalensis* comprised 94% of the total captures, and the remaining 6% comprised of six other species. Statistical analysis of food preferences indicated that both vegetative materials and seeds were significantly ( $p < 0.0001$ ) higher in the diet of *Mastomys natalensis* during the wet and dry seasons compared to other food materials. There were no significant differences in the proportions of both vegetative materials and seeds consumed in fallow land ( $p = 0.42$ ) and maize fields ( $p = 0.31$ ). Similarly, there was no significance ( $p = 0.61$ ) of diet on the reproductive activity *Mastomys natalensis*. Time of year and season did not affect reproductive activity ( $p = 0.96$ ); however, there was a clear non-linear effect ( $p = 0.0005$ ) of time of the year on the proportion of reproductively active animals in the population. Vegetative materials and seeds comprised the largest proportions of the diet of *Mastomys natalensis* and therefore, these food categories correlated positively with reproductive activity. The proportion of vegetative materials and seeds found in the stomach of *Mastomys natalensis* correlated positively with reproductive activity during wet and dry periods respectively. It is recommended that there will be necessary to reduce breeding activity by preventing access to fresh vegetative food (e.g. young sprouting grass).

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## Poster Session 1 – Rodent Management

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### **37 Regional rodent control approach in a countryside in Germany: fostering synergy effects between participating players**

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Commensal rodents cause numerous damages on agricultural operations. Most importantly rodents are carriers of various pathogens that cause human and animal diseases. The control of neophobic rodent populations is therefore common and widespread. Different studies show the importance of pest control strategies in regard to bait station sides, development of resistances against anticoagulant rodenticides as well as collaboration of farmers and Pest Control Operators (PCOs). The aim of the current study is to enhance the effectiveness of pest control measures by applying a comprehensive control of rodent pests in a countryside in Germany. It is known from preliminary analyses, that the participation of farmers to pest control measures can be increased by start-up financing. Therefore, in the current project, the financial contribution of the North Rhine-Westphalian Animal Disease Fund (TSK) will provide incentives to comprehensive pest control measures of commensal rodents in an area of high densities of livestock farming of all kind by PCOs. Indirect monitoring of rodents at the beginning, during and after pest control measures should give information about the colonization of various structures (different livestock farming, communal enterprises and others) with rodents, and their associated pathogenic micro-organisms (viruses, bacteria, parasites). Furthermore, it is part of the project to survey the aspects of the start-up financing and intensive involvement and consulting of all parties on the willingness to participate in the project, as well as active compliance during the program by standardized interviews with farmers and PCOs. To increase long-term implementation of pest control, the intention is to identify supporting and inhibiting factors of implementation practices. Thereby, the regional approach should enhance positive effects of control measures beyond efforts on individual operations. Finally, the synergetic aspects in the guidance of farmers will lead to a decrease in rodent populations in livestock farming thereby preventing enzootic diseases in farm animals in Germany.